DARPA Strategic Technology Office
Contested Environment Strategy and Plans

Dr. Nils Sandell, STO Director

9 May 2014

Strategic Technology Office (STO)
Contested Environment Thrust

STO Systems and Technologies: Core Competencies

- Battle Management/Command and Control (BMC2)
- Communications (C)
- Intelligence, Surveillance and Reconnaissance (ISR)
- Electronic Warfare (EW)
- Positioning, Navigation and Timing (PNT)
- System-of-Systems Integration

STO Contested Environment Thrust: Focus Areas

- Air Dominance against Peer Threat
- Undersea Dominance against Peer Threat
- Spectrum Dominance against Peer Threat

Fighting as a Network to Increase Military Effectiveness, Cost Leverage, and Adaptability

Program Definition Combines Strategy Development (Top Down) with Idea Generation (Bottom Up)

- National, Defense Strategies
- COCOM, Service Needs
- DARPA Investment Themes
- AEO, Liaison Staff, Special Assistant Input, ADI

Strategy Development

- Define key challenges in a mission area
- Conduct operations analysis to include cost asymmetry (cost to deploy vs. cost to defeat)
- Identify strategies that address challenges

Program Definition

What are the gaps, given current programs?

Identify potential transition paths and partners

Invest in areas, programs, and people to fill gaps

- DSO, I2O, MTO, TTO
- Universities
- Industry
- Government Labs and FFRDCs

- Pinpoint technology solutions for STO challenge areas
- Conduct simulation and analysis to quantify solution impacts
- Identify current limitations of state of art and key technical challenges that must be overcome to enable solution.

Idea Generation

Contested Environment Thrust
Goals and Potential Approaches

- Goals: Technologies to Help Enable
  - Air, Undersea and Spectral Dominance* Against Peer Threat
  - Agile Insertion of New Technology
  - Positive Cost Leverage
- Potential Approaches
  - Networking of Low Cost Autonomous Platforms with Manned Platforms
  - Electronic Warfare and Electronic Counter-Counter Measures
  - Electro-Optical (EO) Systems
  - Agile, Jam-Resistant Sensing and Navigation
  - Low Probability of Detection/Anti-Jam Communications
  - Distributed, Deep Ocean Active and Passive Sonar
  - Underwater Operations

*Dominance limited in time and space

Contested Environment Challenges and Strategies – System of Systems

- System of Systems Challenges:
  - Increasing costs and schedule to develop major defense systems with decreasing defense budgets
  - Need systems that cost more to defeat than to deploy
  - Long schedules result in obsolete technology
  - Traditional top down systems engineering failing for system-of-systems: no one is in-charge and too complicated anyway
- System of System Strategies:
  - Leverage commercial components and development processes
  - Development process schedule- and not requirements-driven
  - Use government-owned reference implementations
  - Use simpler, disaggregated, heterogeneous platforms that achieve desired effects by coordinated action
  - Build on successful models (Internet, Microsoft driver development process) to develop system-of-systems integration technology
  - Dual-purpose demonstrations: demonstrate system-of-systems operational capability and the process for developing it

System of Systems Integration Technology and Experimentation (SoSITE)

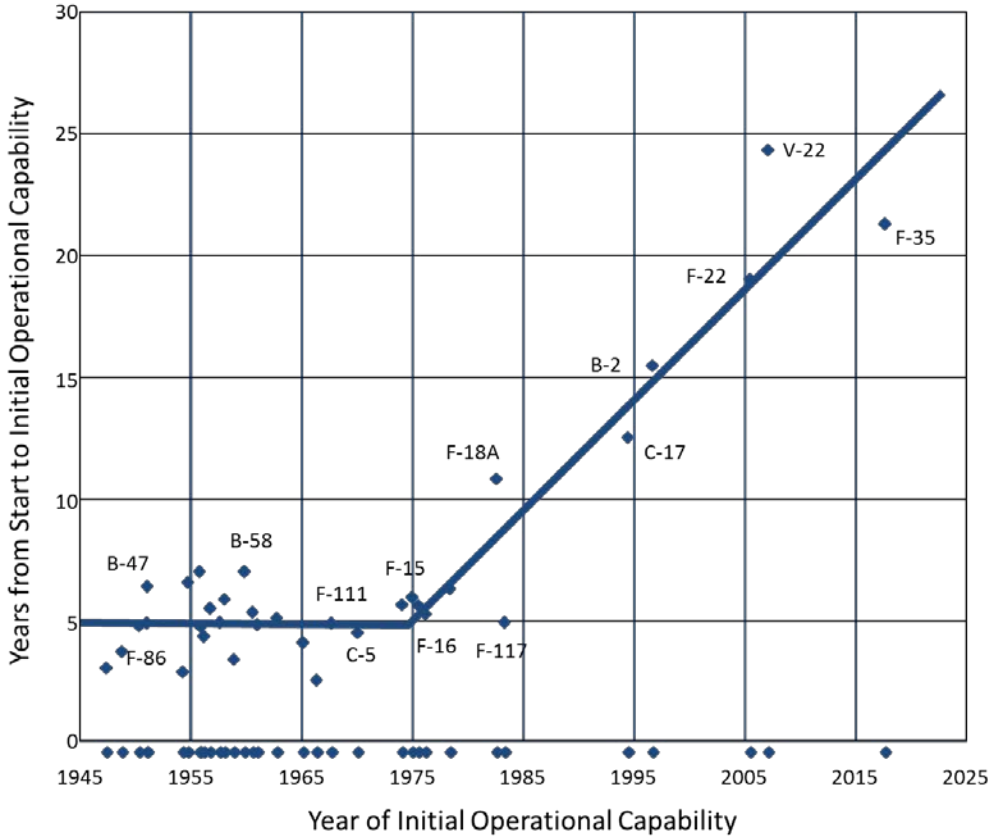
PROGRAM OVERVIEW

Dr. John Shaw, Program Manager

9 May 2014

SoSITE Challenge

- Peers challenging U.S. dominance of space, air, sea, ground and EM spectrum
  - Investing in technologies to produce high-end systems in large quantities
- US platforms take decades to field…
  - Commercial components obsolete before fielding
- …and become expensive to buy
  - F-22 buys went from 750 -> 188



The U.S. must re-think how it builds complex military systems

Rethinking Platform versus System of Systems (SoS)

Platforms

Mission Systems
- Pilot/Operator
- Battle Manager
- Weapons
- Sensor
- Electronic Warfare
- Communications

Rethinking Future Military Systems

Enablers
- System Miniaturization
- Open System Architectures
- Algorithms

System of Systems

Mission Systems
- Electronic Warfare
- Communications

Mission Systems
- Sensor
- Communications

Mission Systems
- Weapons
- Battle Manager
- Communications

SoS Architecture = Selection of platforms + mission systems and the distribution of mission systems across platforms

SoSITE Program Overview

- **Problem** – Near peer threat drives a system of systems approach to incorporate advanced technologies into future kill chains
- **Hypothesis** – System of Systems approach can increase mission effectiveness, cost leverage, and adaptability by:
  - Distributing functionality across platforms offering favorable capability vs cost trades
  - Embracing wide-spread heterogeneity to reduce vulnerabilities, increase agility, and enable competition for capabilities
- **Approach**
  - Architecture Development and Analysis: develop SoS concepts for prototyping and experimentation
  - Integration Technology Development: develop tools to simplify the integration of new technologies into system of systems architectures
  - Experimentation: demonstrate rapid system integration and military utility to validate SoS performance

SoSITE demonstrates rapid integration of advanced technologies to enable robust kill chains in contested environments

System of Systems Risks

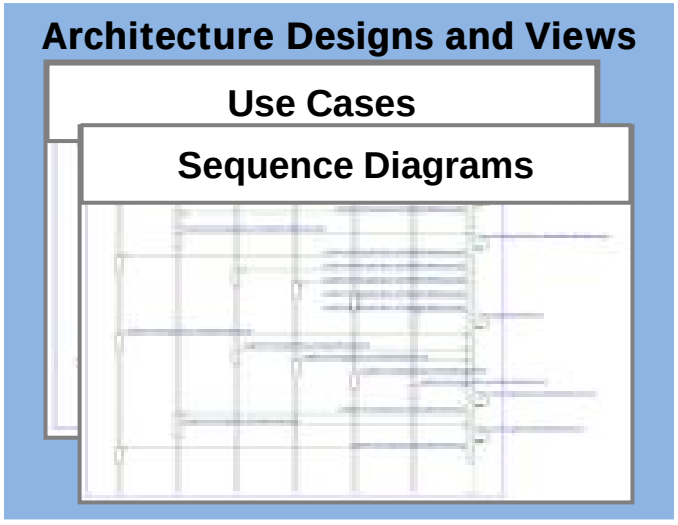
- SoS approach has risks the SoSITE program will address
  - Architecture Development and Analysis
    - Architecture too complex to work reliably in combat
    - Architecture too dependent on fragile communications links
    - Platforms design for low cost turn out to be costly
    - Level of autonomy needed is beyond state-of-art
    - Low cost platforms lack reach/persistence to be effective in contested environments
    - Low cost platforms lack size/weight/power to carry necessary mission systems
  - Integration Technology Development
    - SoS integration costly and slow
    - Platforms and subsystems from different contractors are incompatible
  - Adoption
    - Services buy and Congress allocates budgets for platforms - not Systems of Systems

Architects Produce SoS Architecture Options for Experimentation

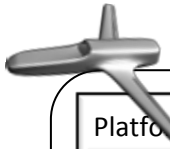
System Options
- Platforms
- Weapons
- Sensors
- Mission Systems

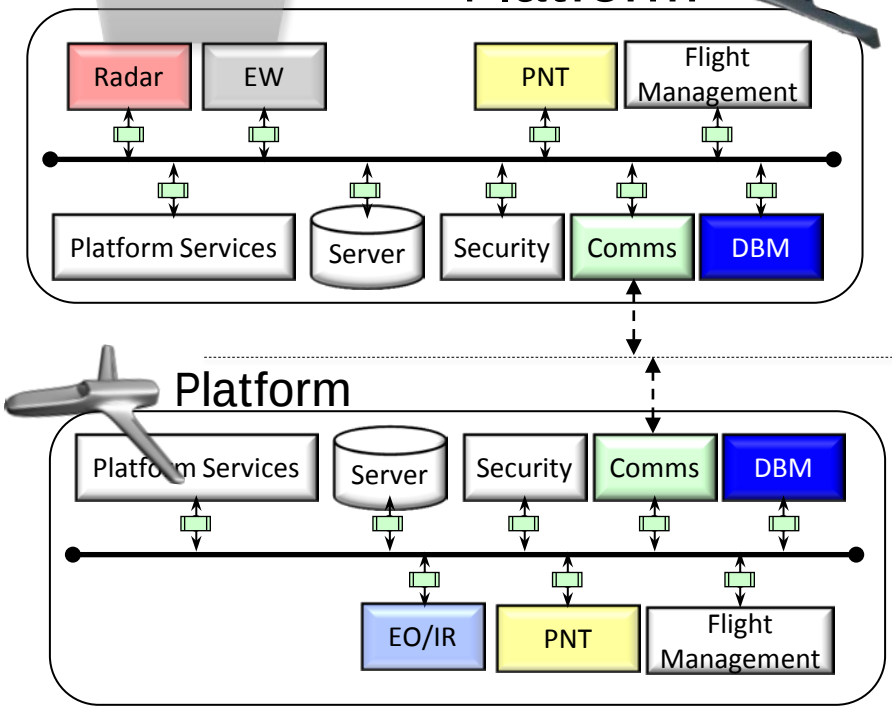
SoS Concepts

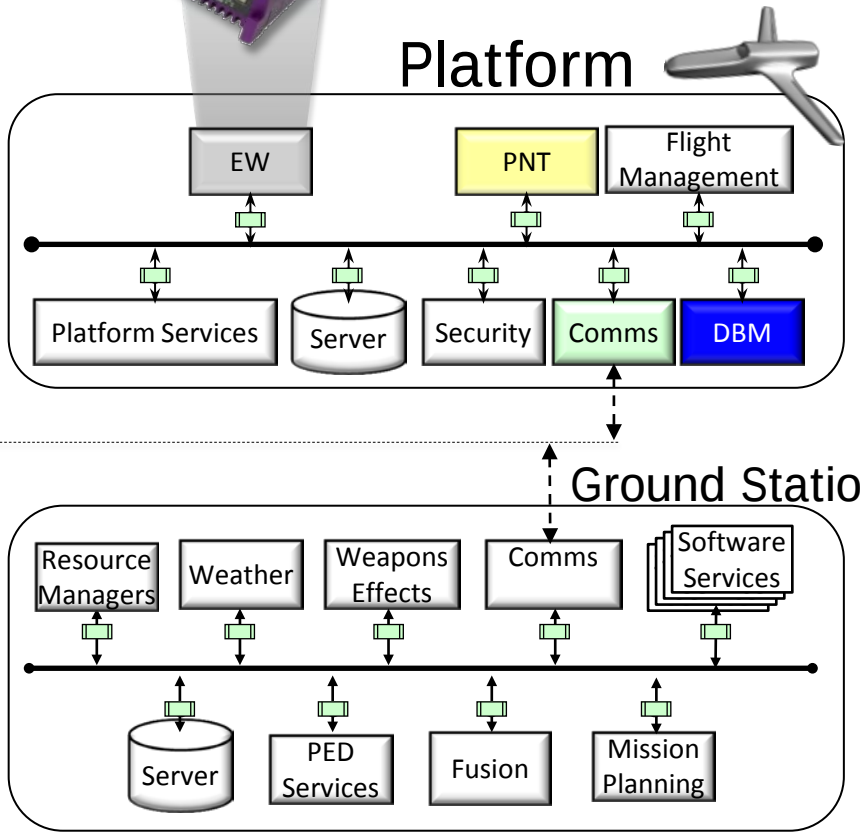
SoS Architectures



Architecture Options Determine How to Best Distribute Functionality Throughout a SoS







LRU: Line Replaceable Unit
EW: Electronic Warfare
EO/IR: Electro Optical/Infrared

PNT: Positioning, Navigation, Timing
OFP: Operational Flight Program
DBM: Distributed Battle Management

PED: Processing, Exploitation, Dissemination

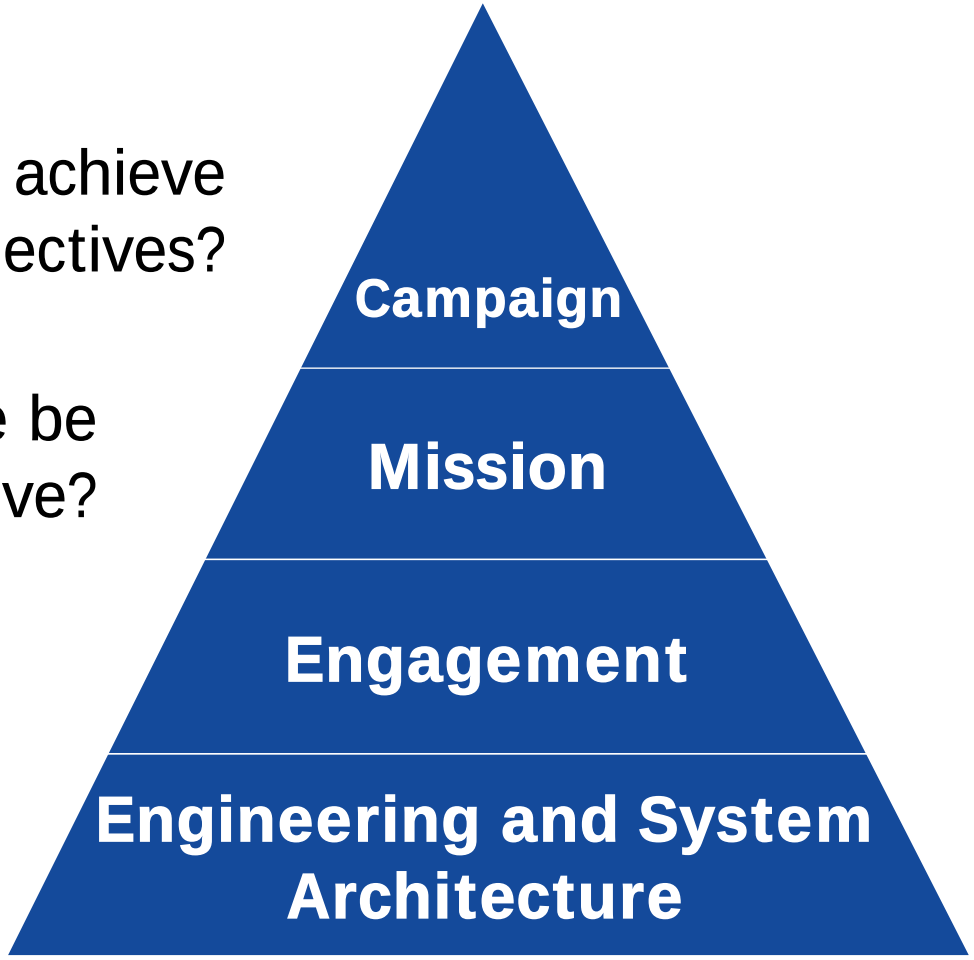
Architects Provide Analysis Frameworks to Validate Architecture Options

Will this architecture achieve operational objectives?

Will this architecture be effective?

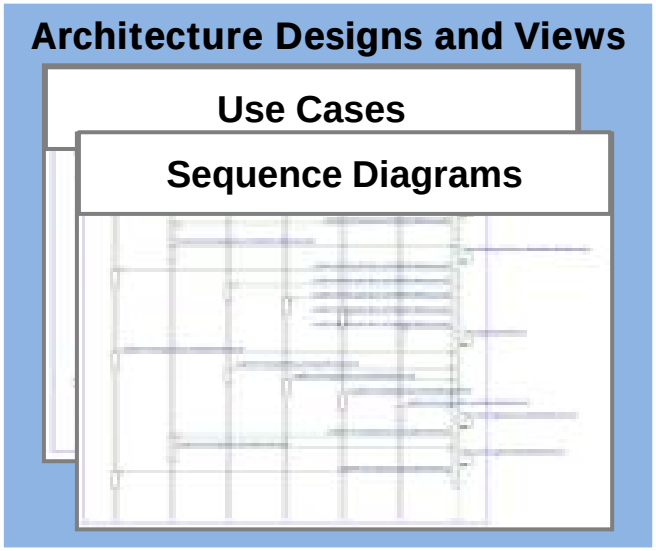
How well will this architecture perform?

How will this architecture operate?



Architects Refine Architectural Products to Produce Demonstrable Objective Architectures

- Develop architectural products through OV-6 to
  - Describe uses the architectures support
  - Show key technical interfaces
  - Verify the architectures account for all systems and activities required to be put to use



Use cases

Objectives; Actors; Pre-conditions; Activities; Interfaces; Post-conditions

Activity diagrams (OV-5): what is to be performed to accomplish the mission?

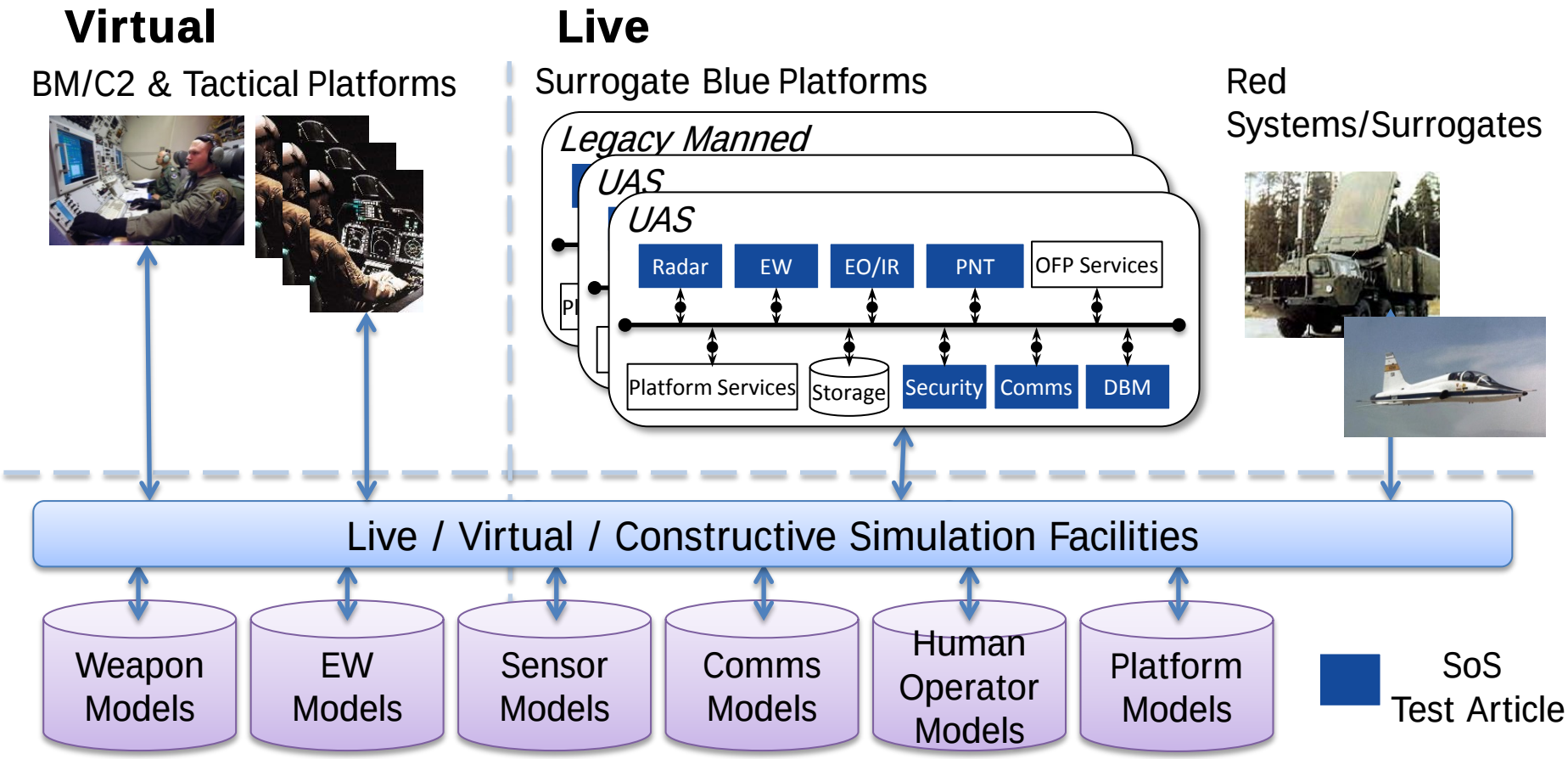
Resource flow diagram (OV-2): who are the actors and how do they interface?

Resource flow matrix (OV-3): what is to be exchanged?

Activity models (OV-6): in what order are the events and the information exchanges between actors?

Architects Plan High-Fidelity Experiments to Test their Objective Architectures

- Follow-on phase (NOT part of BAA-14-40) will conduct experiments at Government ranges and simulation facilities



EW: Electronic Warfare
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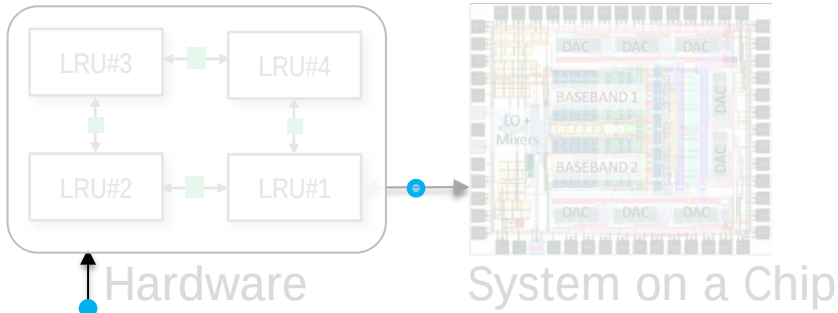
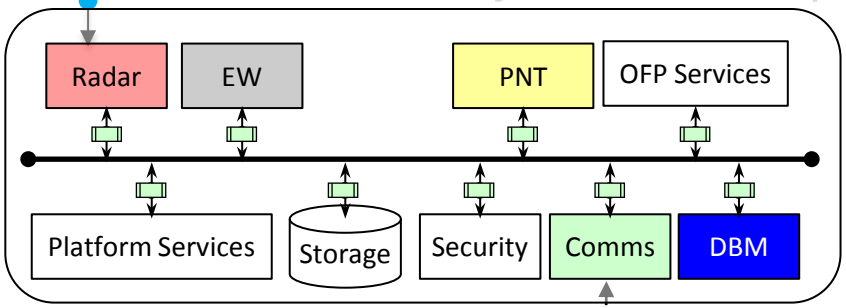
C2: Command and Control

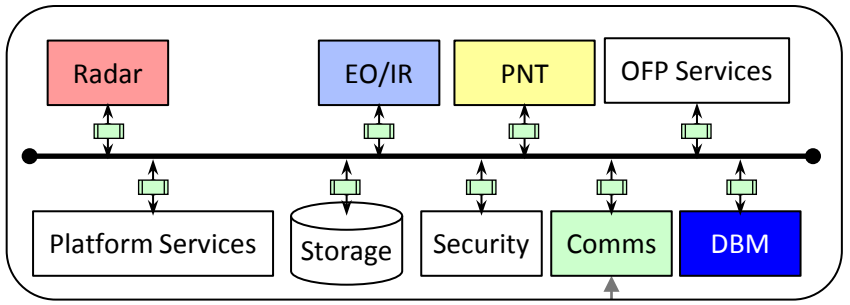
Integration Technologies Simplify System Integration and Enable Architecture Evolution



SoS Integration Technology Objectives

- Enable affordable capability evolution
- Enable competition across the life cycle
- Enable resiliency against evolving threats
- Simplify mission system integration and sustainment



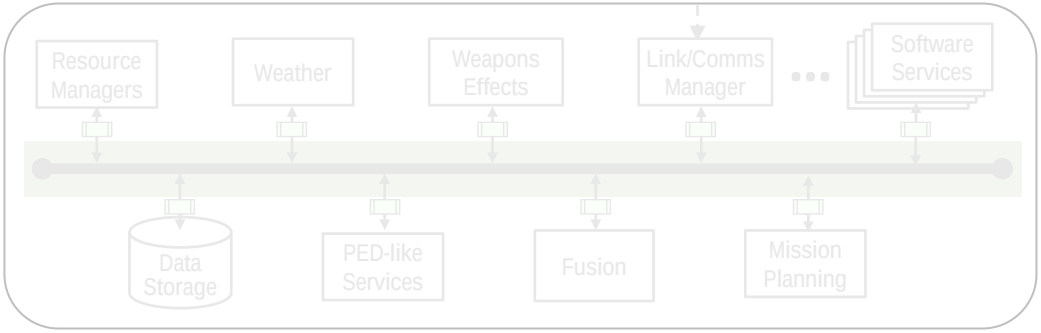


Platform

Platform

Integration Technologies Thrust

- Leverage open system/architecture initiatives
- Enable architecture evolution
- Enable efficient regression testing
- Build security into the architecture



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Integration Technologies

- Thrust 1: Adaptable system interfaces
  - Issue: architectures based upon message standards become rigid and difficult to change
  - Prospective mitigation: adaptable interfaces to incorporate message extensions into architectures without modification to unaffected components
- Thrust 2: Compositional Verification
  - Issue: regression testing and validation to add new systems takes much effort
  - Prospective mitigation: compositional verification enabled by systems specifying testable properties through interfaces
- Thrust 3: Cyber security
  - Issue: open architecture approaches can increase attack surface
  - Prospective mitigation: strongly-separated components, blocking of unpermitted transactions; trusted transaction monitoring

SoSITE Program Structure

PHASE 1

- TA1 – SoS Architecture Development and Analysis
  - Synthesis and validation leading to candidates for prototyping and experimentation
  - Plan five experiments for a follow-on Phase 2*
  - Products: architecture synthesis tools, System of System architectures, experiment plans
- TA2 - SoS Integration Technology Development
  - Tools to enable architecture evolution, efficient testing, and cyber security
  - Adopting the tools to a Government-provided Open System Architecture
- Government Team
  - Architecture path finding, test development, independent validation

PHASE 2

- SoS Experimentation
  - Integrate SoS builds and flight test, refine integration technologies
  - 6-month intervals demonstrating military utility against future threats

** Phase 2 is NOT part of BAA-14-40*

SoSITE Will Align with Service/OSD Open System Architecture (OSA) Initiatives

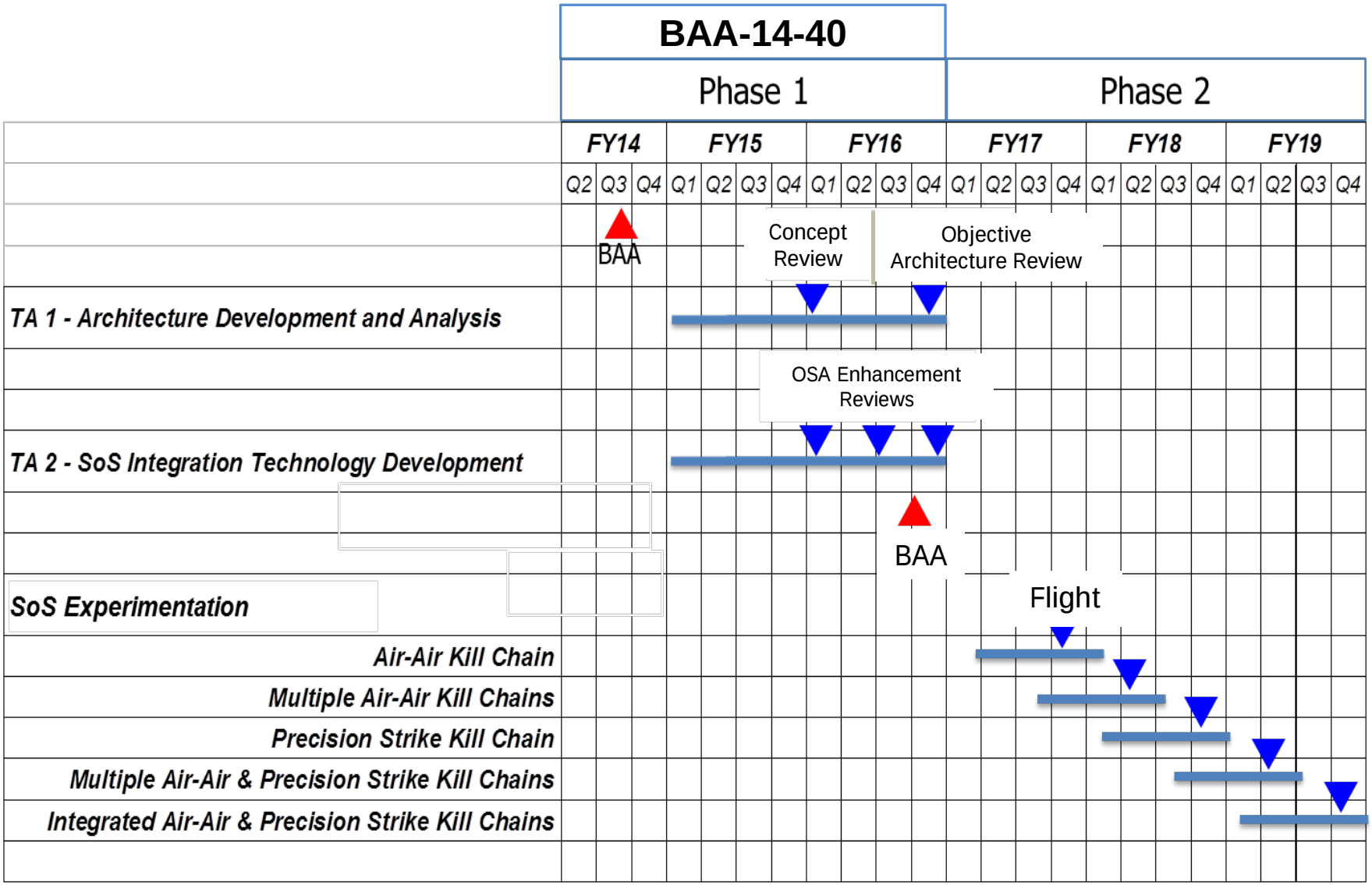
- Many OSA initiatives ongoing
  - Direct SoSITE performers to support them all?
  - Select one and let the Government handle the alignment with other initiatives?
- SoSITE chose the latter option
  - Air Force / Rapid Capability Office (RCO) - Open Mission Systems (OMS)
  - Alignment with OMS will not be required until Year 2 of the program
  - Prior knowledge of OMS is not required to respond to the SoSITE BAA
- Government will provide a reference OSA toolkit, based on OMS, as GFI to performers at Contract Award

GFI: Government-Furnished Information

Government System Integration Lab (SIL) will Verify Alignment with the Open System Architectures

- TA2 performers will provide their tools, adopted to the OSA, to the Government for demonstration to the TA1 performers
  - Government will demonstrate potential to assist TA1 performers, and provide enhanced OSA releases following OSA Enhancement reviews
- TA1 performers determine extensions to their OSA distribution, as needed, for their Objective Architectures
  - TA1 performers reserve the right to decide whether to use the enhanced OSA releases
  - Provide their Objective Architectures, with any OSA extensions, for Government-run SIL demonstration (Objective Architecture Review)

SoSITE Program Schedule



Responses to the BAA will Propose Metrics and How Performers Intend to Quantify Them

Metric Class	Comment
Military Utility	TA1 only. Provide a logical progression of metrics through your analytic framework--Engineering, Engagement, Mission, Campaign--and how your technical approach quantifies them
Cost Imposition	TA1 only. SoSITE seeks metrics relating adversary ownership cost to defeat a SoS to U.S. ownership cost of the SoS
Adaptability	For TA1: the ability of the SoS architecture design to assimilate new systems, serve new missions For TA2: • Elimination—or reduction—of community consensus required to change interfaces (Adaptable Interfaces thrust) • Reduction of effort required to verify a SoS can achieve mission objectives (Compositional Verification thrust) • Resistance to exploitation (Cyber defense thrust)

Government-Furnished Information

- TA1
  - A distribution of the Open Mission System (at contract award)
  - Mission scenarios for two peer threats circa 2030 (at contract award)
  - Technical specifications for select DARPA programs (throughout Phase 1)
- TA2
  - A distribution of the Open Mission System (at contract award)
  - Unclassified models for notional SoS elements—platforms, weapons, sensors, and mission systems (at contract award)

The SoSITE Program will be Conducted at Multiple Security Levels

- Anticipate TA1 products will be at unclassified, collateral SECRET, TOP SECRET Sensitive Compartmented Information (SCI) and Special Access Required (SAR) levels
  - Anticipate most architecture development and evaluation will be TS/SCI/SAR
  - Breakout meeting later this morning with Program Security Officers from organizations interested in responding to TA1
- Anticipate TA2 performers will produce products at the unclassified and collateral SECRET levels

Proposal Evaluation Criteria

- Overall Scientific and Technical Merit: approach is feasible, achievable, complete, supported by a technical team with the expertise
- Potential Contribution and Relevance to the DARPA Mission: contributions of the proposed effort are relevant to the national technology base
- Realism of Proposed Schedule: aggressively pursues program objectives and mitigates potential schedule risk
- Proposer's Capabilities and/or Related Experience: proposer's ability to deliver products relevant to SoSITE on schedule and budget
- Cost Realism: costs are realistic for the technical and management approaches offered, and demonstrate the proposer understands the effort
- Security: approach to operating at the multiple security levels complies with DoD 5220.22-M

Criteria in Overall Scientific and Technical Merit Specific to Each Technical Area

- TA1: the extent the proposer demonstrates their technical approach:
  - Provides quantitative baseline assessments of existing and planned US capabilities versus peer threats to prioritize US capability gaps
  - Uses system architecture synthesis and modeling to develop and analyze potential system of system concepts to eliminate capability gaps
  - Expresses prospective SoS architectures using the DoDAF to expose architecture elements, their roles, and their interactions
  - Supports independent evaluation of proposed architectures in Government integration and simulation facilities
- TA2: the extent the proposer demonstrates their technical approach:
  - Enables a SoS to evolve and adapt to new technologies
  - Enables a SoS to accommodate large-scale diversity among its constituent elements
  - Diminishes the effort to verify a SoS satisfies mission objectives (Thrust 2 only)
  - Reduces vulnerability to cyber attack (Thrust 3 only)

Submission Highlights

- Proposers May Bid on Both TA 1 and TA2
  - Must submit separate proposals
  - Multiple thrusts in TA 2 may be combined into one proposal, or submitted as separate proposals
- Key Dates
  - BAA Posting Date: 30 April, 2014
  - Industry Day: May 9, 2014
  - Questions Due Date: 15 May, 2014
  - Proposal Due Date: 13 June, 2014
- Email address: DARPA-BAA-14-40@darpa.mil
- STO's BAA Website: http://stobaa.darpa.mil